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BONE TURNOVER MEASURED WITH SIX QUANTIFICATION METHODS USING ¹⁸F-FLUORIDE PET

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INTRODUCTION

The non-invasive assessment of regional bone metabolism using ¹⁸F-fluoride positron emission tomography (¹⁸F-PET) can aid in understanding the pathophysiology of metabolic bone diseases such as osteoporosis.

The aim of this study was to evaluate the relationship between five different quantification methods against the three compartment four parameter model (Ki-4k), used as the gold standard, for the measurement of regional bone turnover (Ki, representing the net plasma clearance to bone mineral) using ¹⁸F-PET at the hip and lumbar spine.

METHODS

Twelve healthy postmenopausal women aged 52-71 years, with no history of metabolic bone disease (except untreated osteoporosis in the spine) and not currently on treatments affecting skeletal metabolism were recruited.

Each subject had 60 minutes dynamic ¹⁸F-PET scans at the lumbar spine and hip two weeks apart with injected ¹⁸F-fluoride activities of 90 MBq and 180 MBq respectively.

Arterial input functions were obtained from images of the aorta in the same datasets in order to determine Ki values at both the sites using a Ki-4k, three compartment three parameter model (Ki-3k), Patlak analysis (Ki-Pat), spectral analysis (Ki-Spec), deconvolution analysis (Ki-Decon) and Standardised uptake value (SUV).

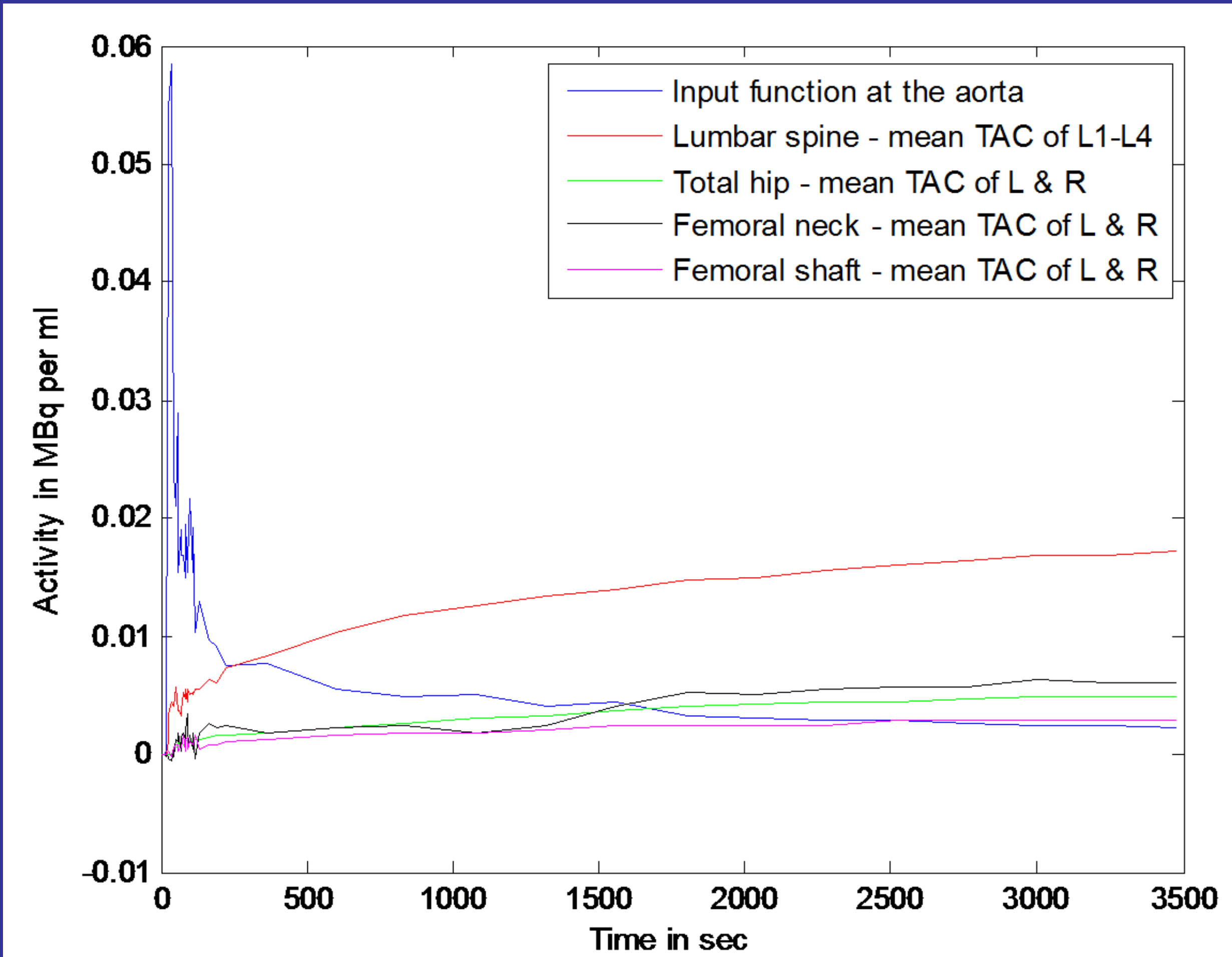


FIGURE 1: The image derived arterial plasma input function at the aorta and bone time activity curves at the hip and lumbar spine.

RESULTS

For Ki at the hip, the correlation between Ki-4k with Ki-Spec, Ki-Pat, Ki-Decon, SUV and Ki-3k were 0.95, 0.89, 0.89, 0.91 and 0.59 respectively (Table 1).

For Ki at the lumbar spine, the correlation between Ki-4k with Ki-Spec, Ki-Decon, Ki-Pat, Ki-3k, SUV were 0.89, 0.89, 0.86, 0.82, 0.78 respectively (Table 1).

For the combined Ki at the hip and lumbar spine, the correlation between Ki-4k with Ki-Pat, SUV, Ki-Decon, Ki-3k, Ki-Spec were 0.95, 0.95, 0.93, 0.93, 0.88 respectively (Table 1).

The differences between the correlations measured using Fisher's Z-test were not significant (p>0.05).

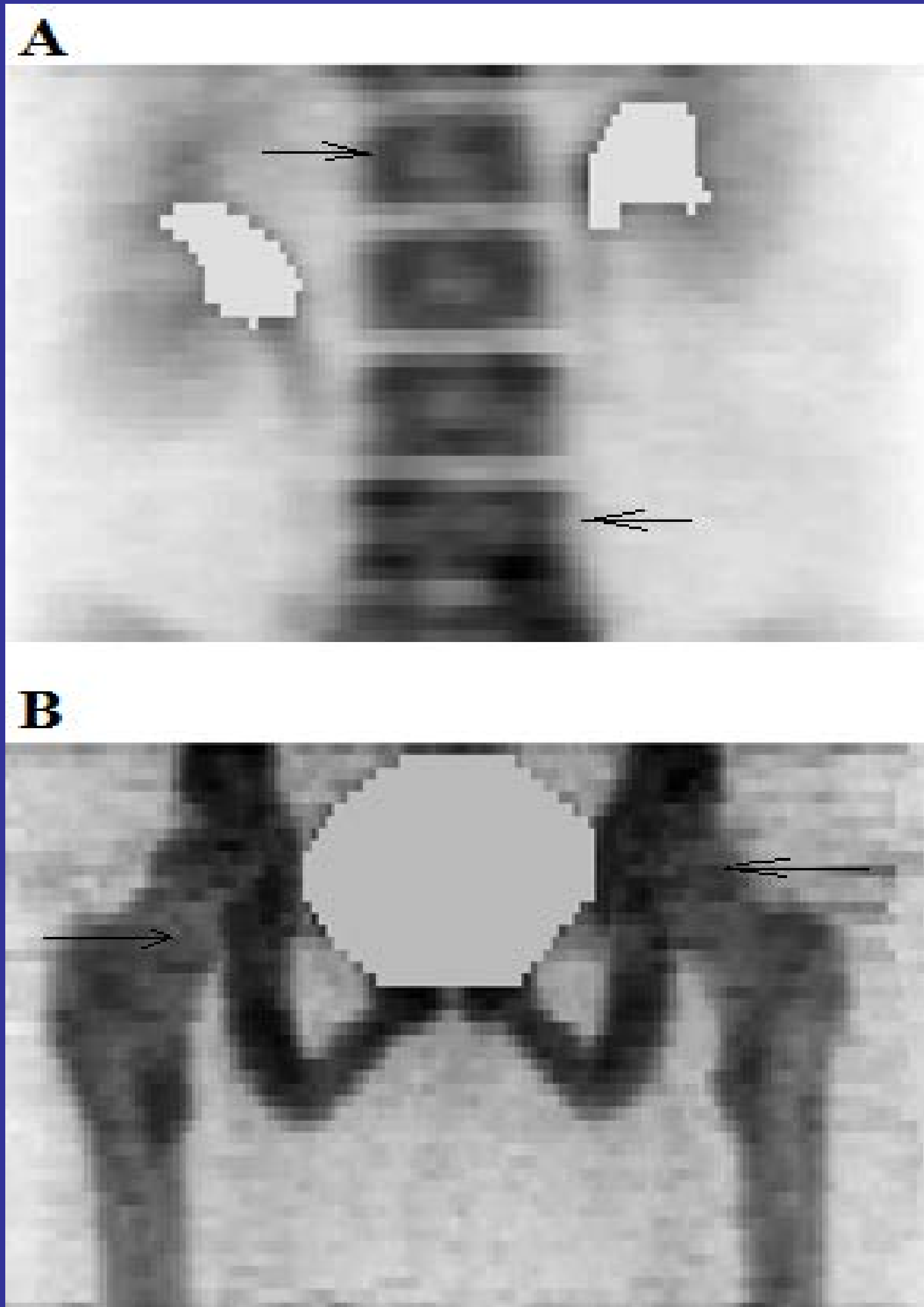


FIGURE 2: Example of dynamic summed images of ¹⁸F-fluoride PET scan used to measure SUV. The images were zoomed for clear visibility as the original size of the images was 128 X 128 x 47 pixels in x, y and z directions.

(A) Coronal view of the lumbar spine scan shows L1 with the arrow on the top and L4 with the arrow at the bottom,

(B) Coronal view of the hip scan shows femoral neck with the arrow on the left and femoral head with the arrow at the right. The activity within kidneys and bladder has been removed from image.

CONCLUSION

We concluded that all five methods of quantification (Ki-3k, Ki-Pat, Ki-Spec, Ki-Decon and SUV) strongly correlate with Ki-4k.

However, care should be taken when comparing reports that use different methods of quantification.

The semi-quantitative SUV correlated just as well with Ki-4k estimates as the other dynamic quantification methods.

However, it is not yet clear if the SUV is a good indicator of measuring changes in bone turnover for therapeutic purposes since no studies have been performed directly comparing the changes in SUV with the changes in bone histomorphometric data as a measure of gold standard.

K _{i-4k}	Spine (p-value)	Hip (p-value)	Combined (p-value)
K _{i-3k}	0.82 (0.0012)	0.59 (0.0436)	0.93 (<0.0001)
K _{i-Pat}	0.86 (0.0004)	0.89 (0.0001)	0.95 (<0.0001)
K _{i-Spec}	0.89 (<0.0001)	0.95 (<0.0001)	0.88 (<0.0001)
K _{i-Decon}	0.89 (0.0001)	0.89 (<0.0001)	0.93 (<0.0001)
SUV	0.78 (0.0028)	0.91 (<0.0001)	0.95 (<0.0001)

TABLE 1: Pearson correlation and their significance values between Ki-4k and other methods measured at the hip, lumbar spine and combined values.

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